Customer No.: 052054
Application No.: TBD
Applicant: Hiroyuki Nakata et al.
Atty. Docket No.: 40647

FIG. 1

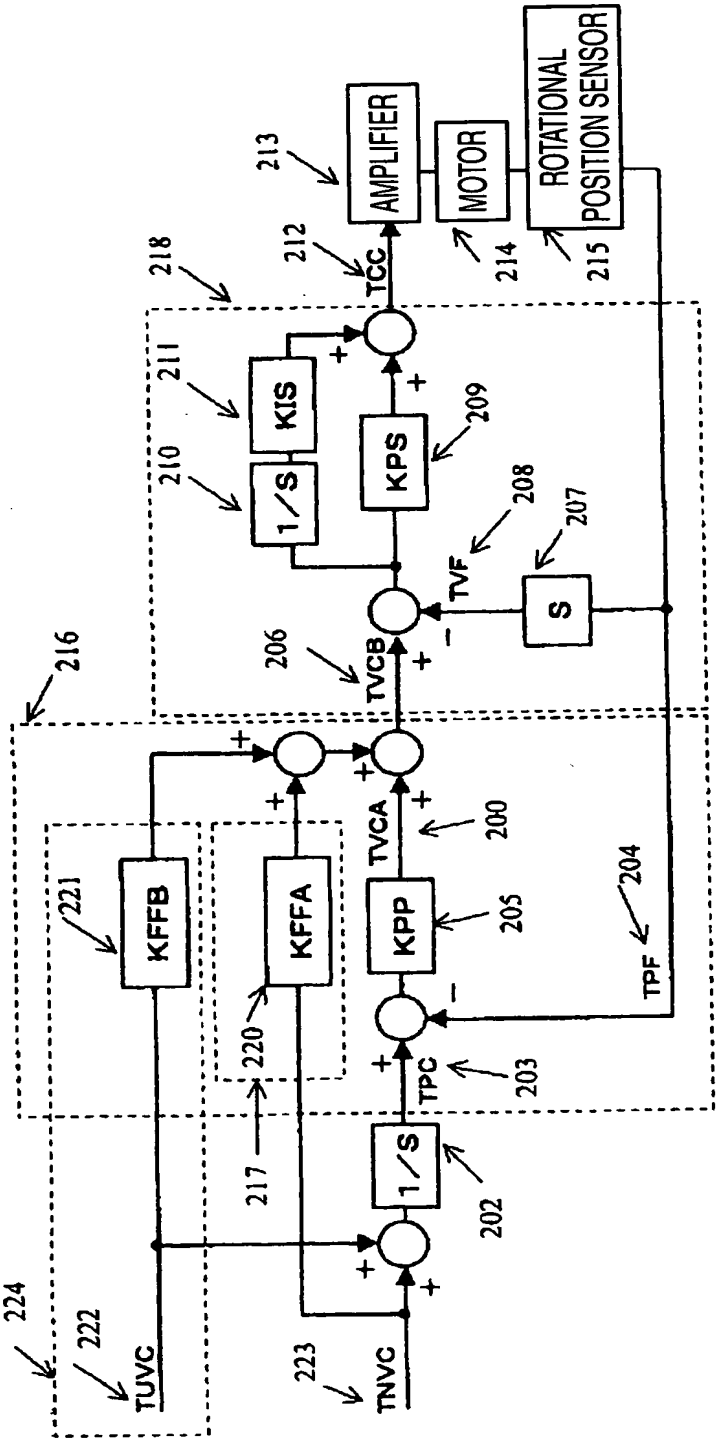


FIG. 2

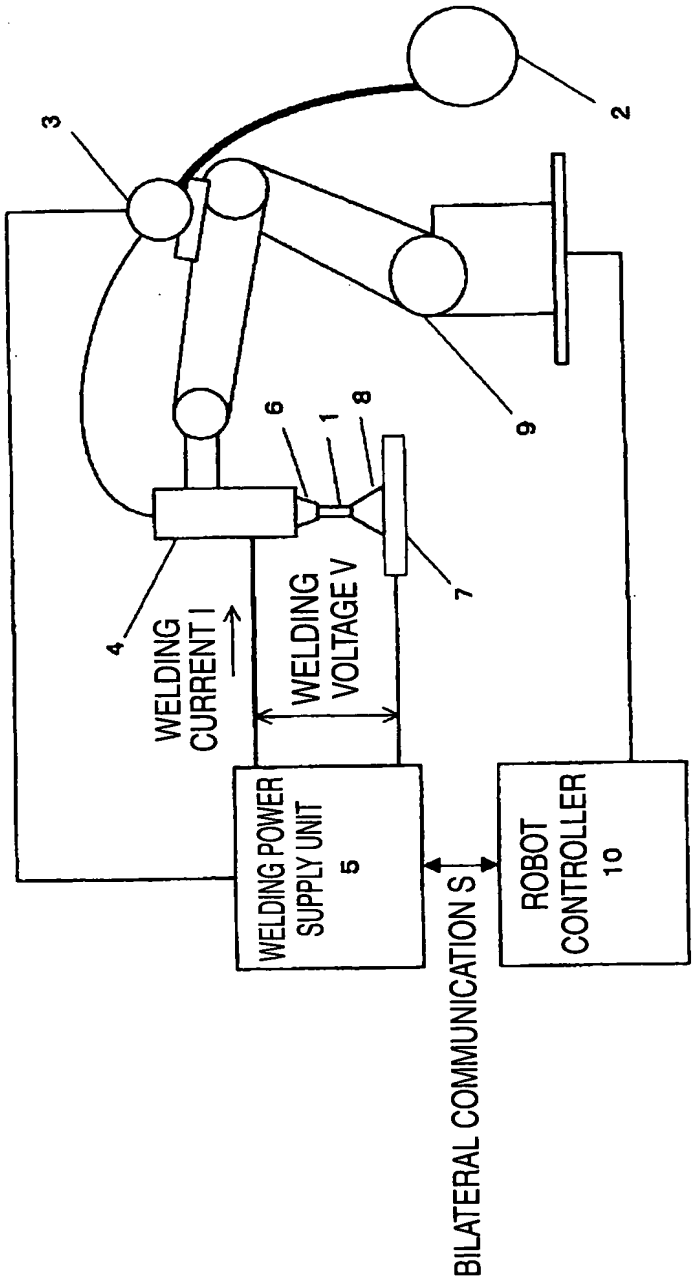

2
3
9
6
1
8
7
4
WELDING CURRENT I
WELDING VOLTAGE V
WELDING POWER SUPPLY UNIT 5
ROBOT CONTROLLER 10
BILATERAL COMMUNICATION S

FIG. 3

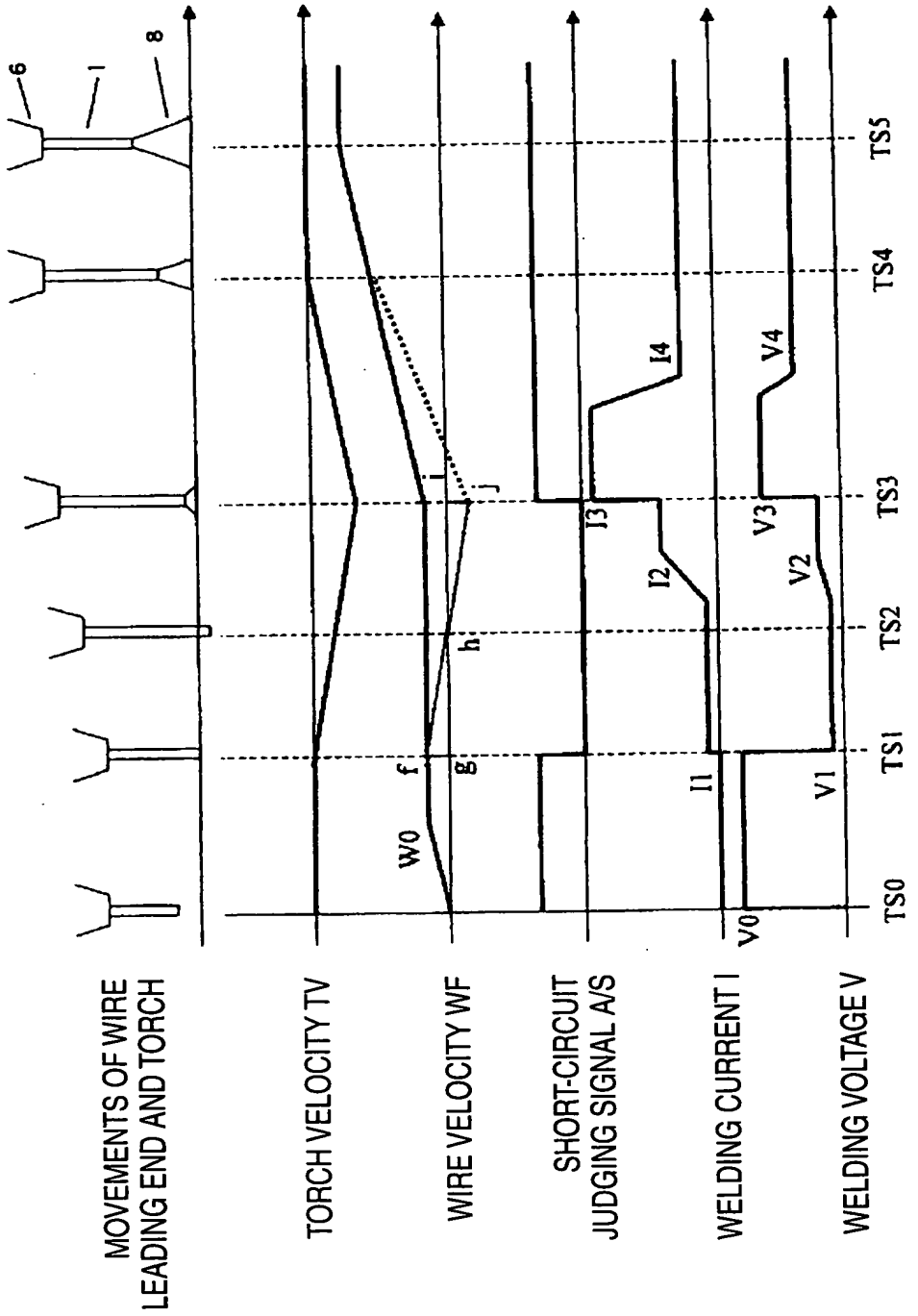

MOVEMENTS OF WIRE LEADING END AND TORCH
TORCH VELOCITY TV
WIRE VELOCITY WF
SHORT-CIRCUIT JUDGING SIGNAL A/S
WELDING CURRENT I
WELDING VOLTAGE V
6
1
8
W0
f
g
h
i
j
I1
I2
I3
I4
V0
V1
V2
V3
V4
TS0
TS1
TS2
TS3
TS4
TS5

FIG. 4

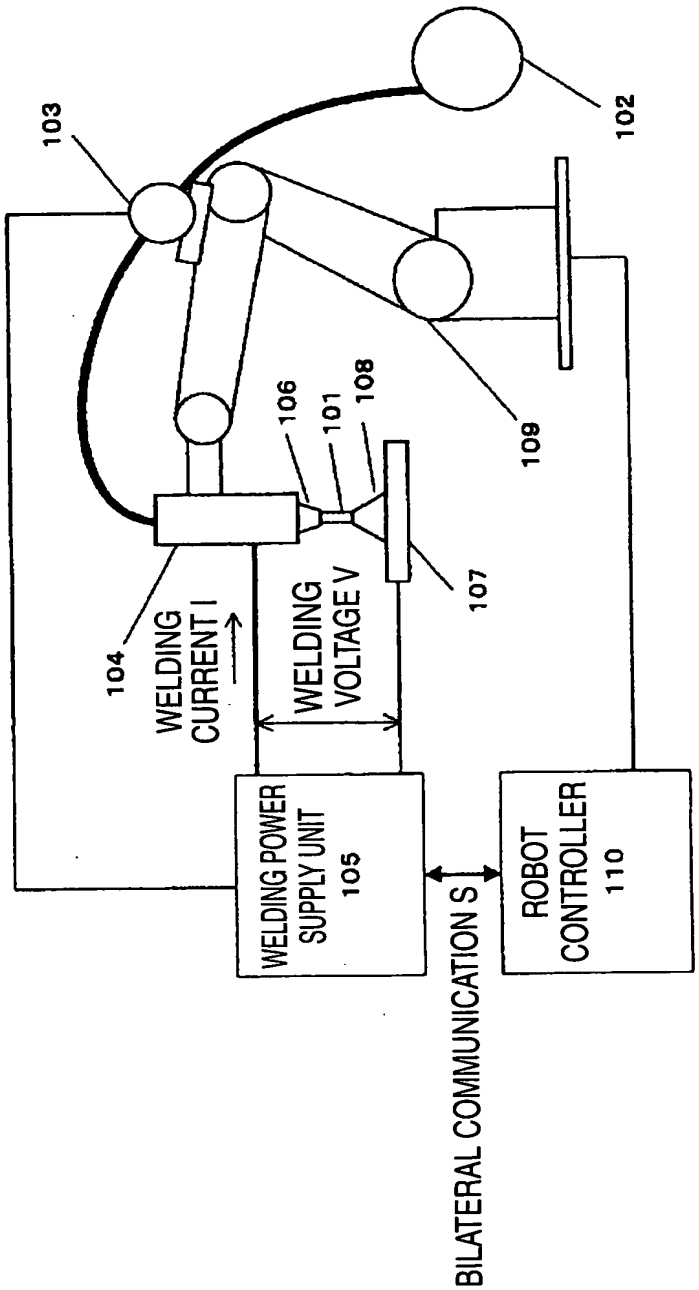
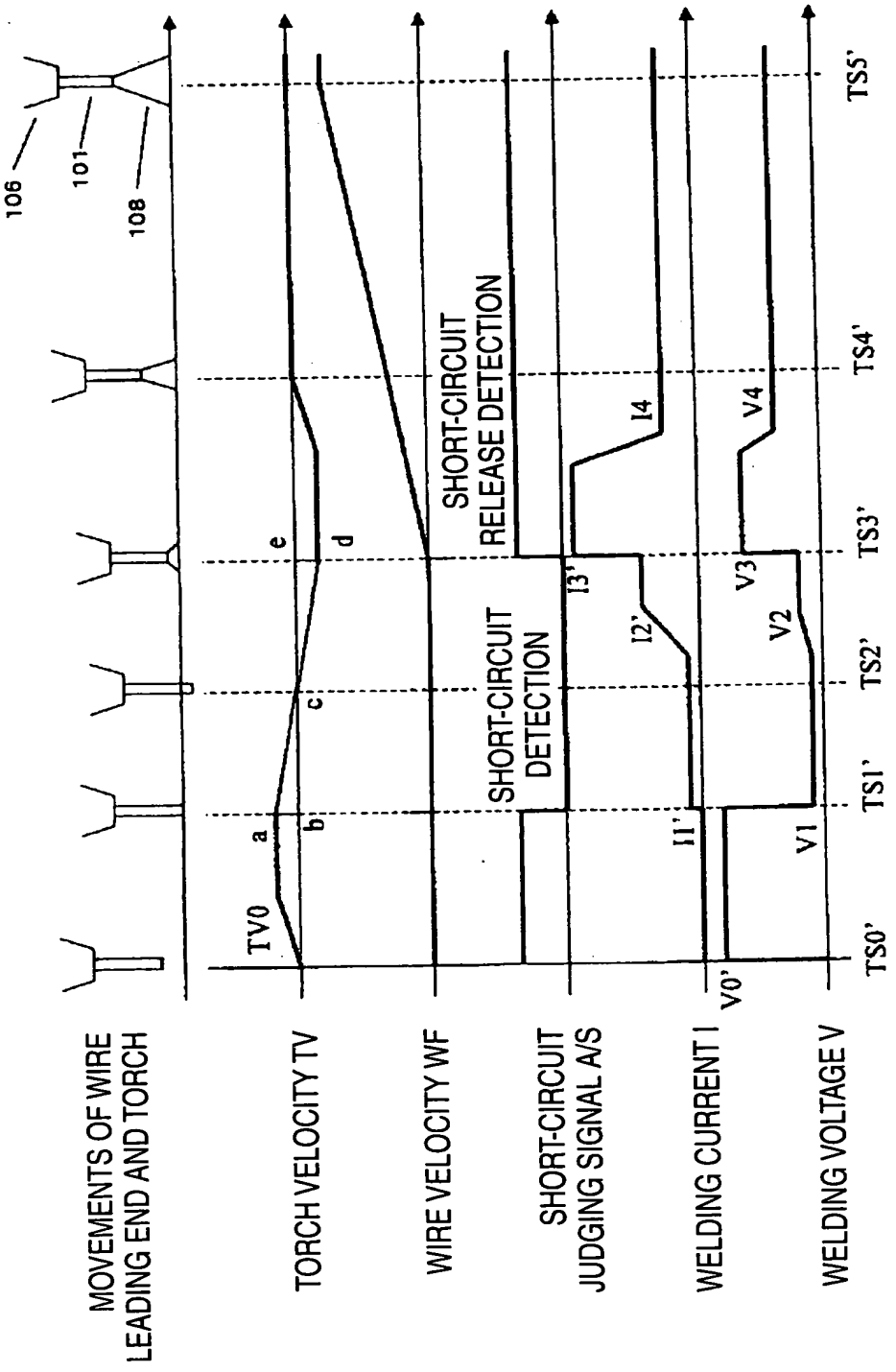

103
102
106
101
108
109
104
WELDING CURRENT I
WELDING VOLTAGE V
107
WELDING POWER SUPPLY UNIT 105
ROBOT CONTROLLER 110
BILATERAL COMMUNICATION S

FIG. 5


MOVEMENTS OF WIRE LEADING END AND TORCH
TORCH VELOCITY TV
WIRE VELOCITY WF
SHORT-CIRCUIT JUDGING SIGNAL A/S
WELDING CURRENT I
WELDING VOLTAGE V
106
101
108
TV0
a
b
c
d
e
SHORT-CIRCUIT DETECTION
SHORT-CIRCUIT RELEASE DETECTION
I1'
I2'
I3'
I4
V0'
V1
V2
V3
V4
TS0'
TS1'
TS2'
TS3'
TS4'
TS5'

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Application No.: TBD
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Atty. Docket No.: 40647

FIG. 6

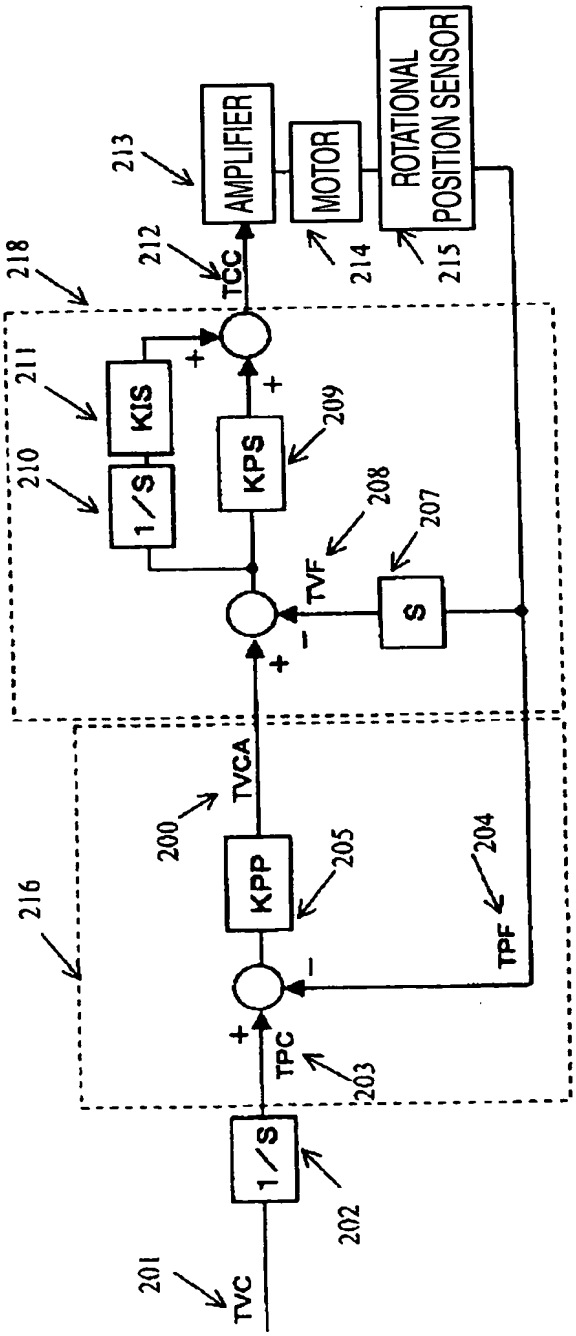
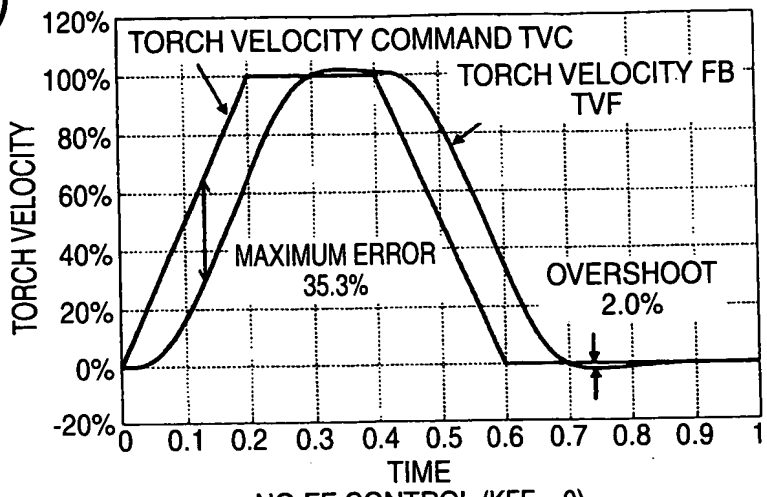
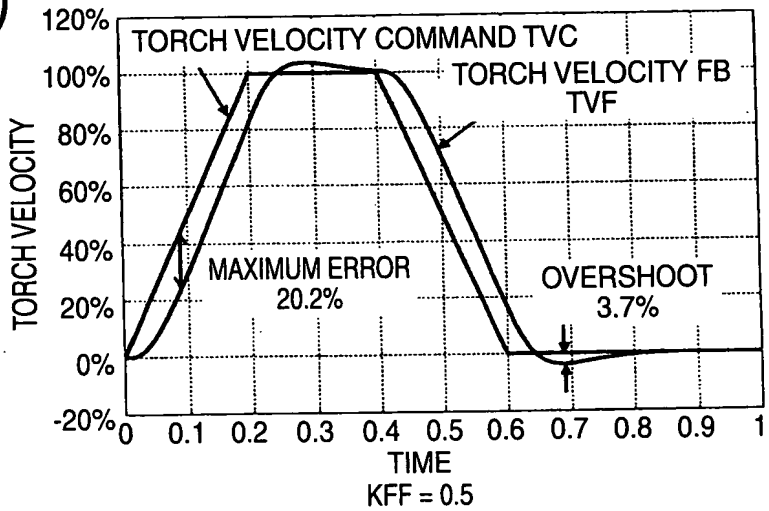


FIG. 7 (a)



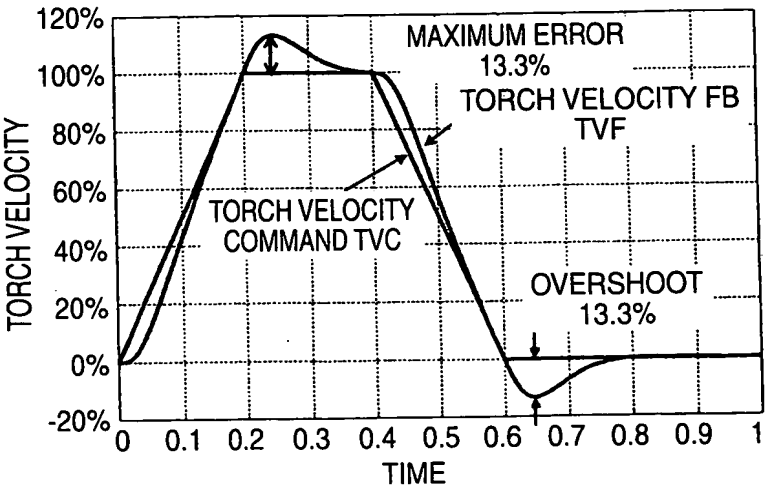

NO FF CONTROL (KFF = 0)

FIG. 7 (b)



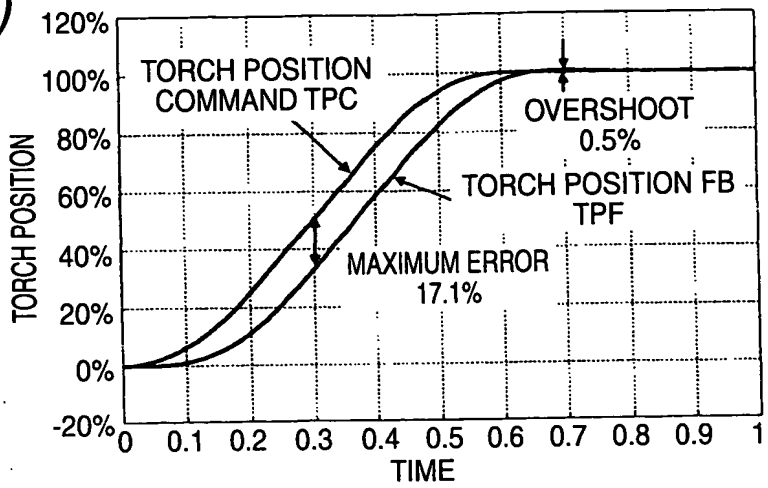

KFF = 0.5

FIG. 7 (c)



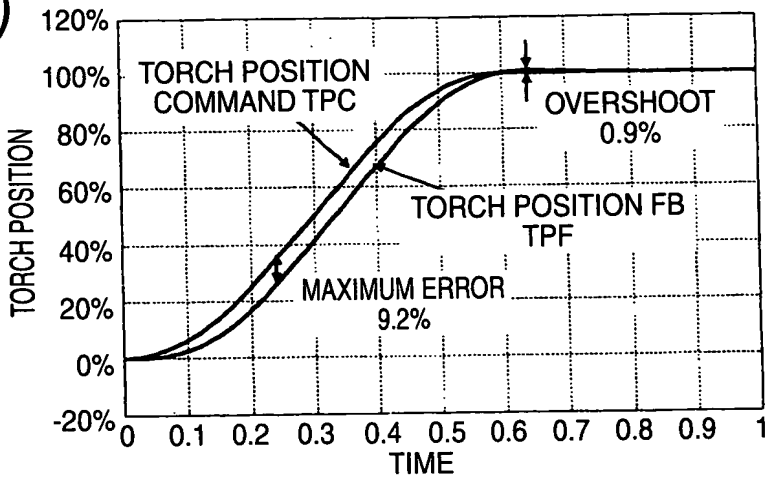

KFF = 1.0

FIG. 8 (a)



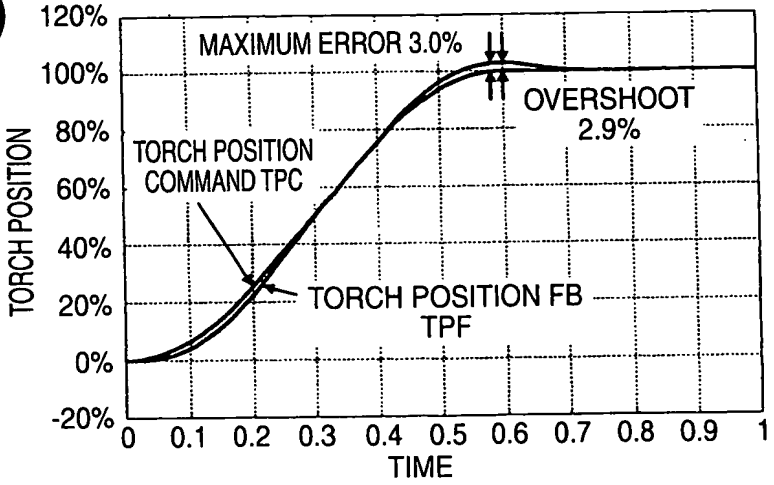

NO FF CONTROL (KFF = 0)

FIG. 8 (b)




KFF = 0.5

FIG. 8 (c)




KFF = 1.0

FIG. 9

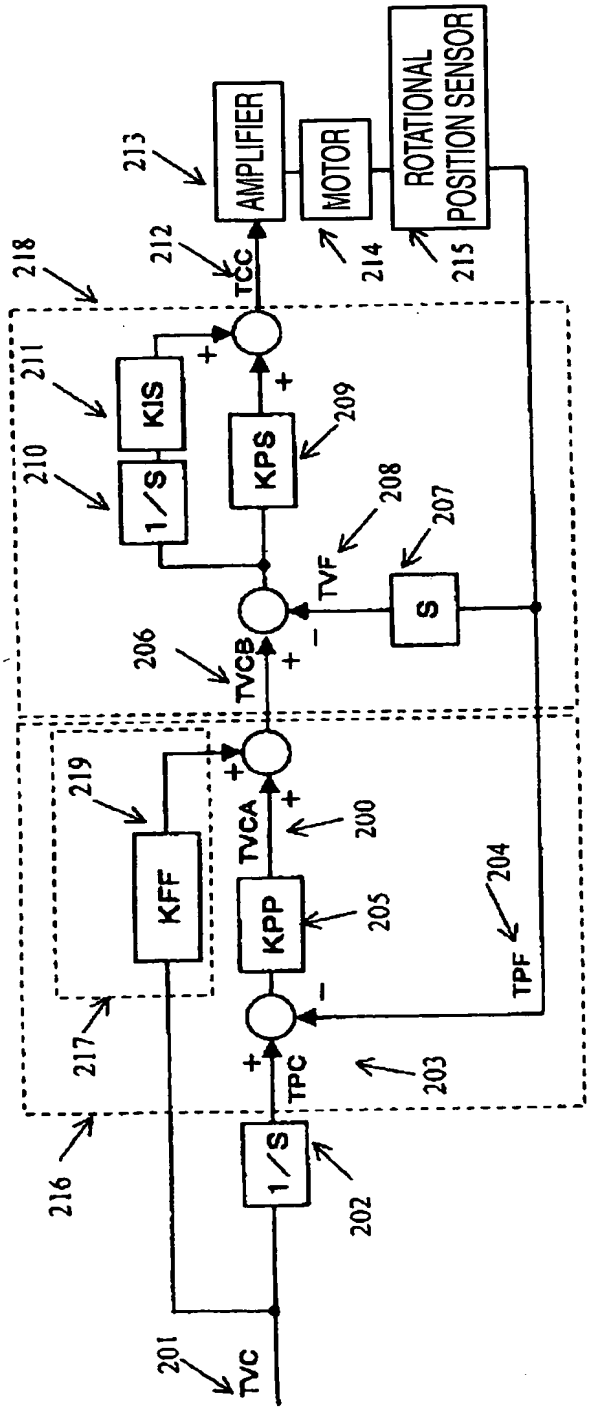

AMPLIFIER
MOTOR
ROTATIONAL POSITION SENSOR
213
214
215
212
TCC
218
211
KIS
210
1/S
209
KPS
208
TVF
207
S
206
TVCB
219
KFF
TVCA
200
KPP
205
204
TPF
217
TPC
203
216
1/S
202
201
TVC

FIG. 10 (a)

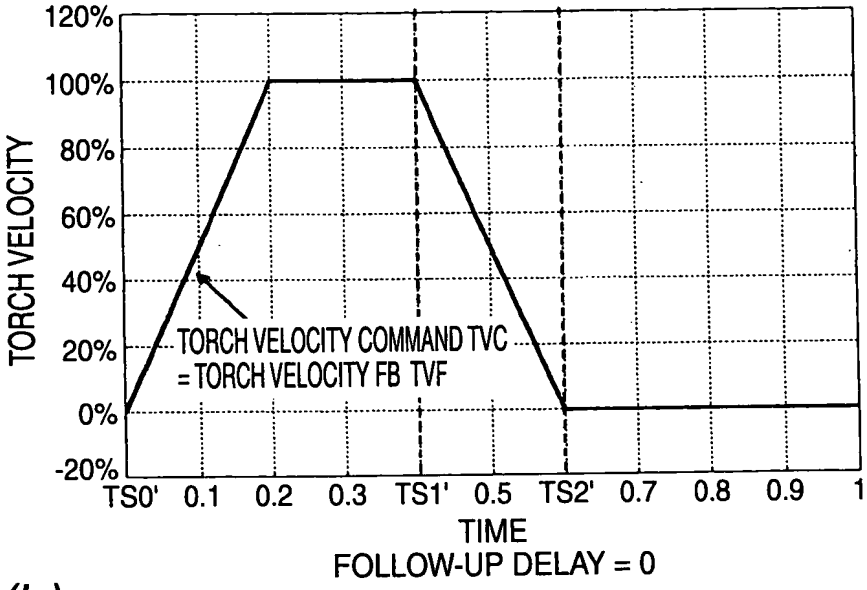



FIG. 10 (b)

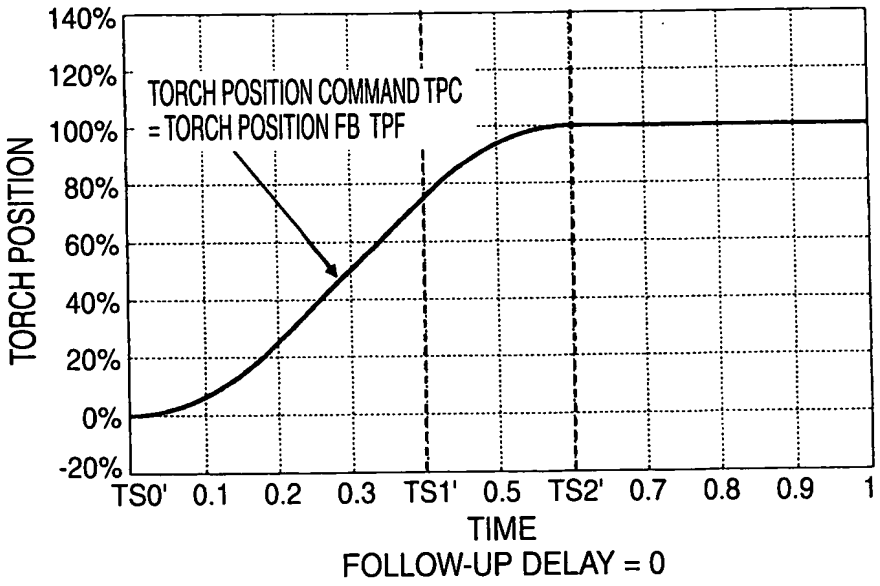


FIG. 11 (a)

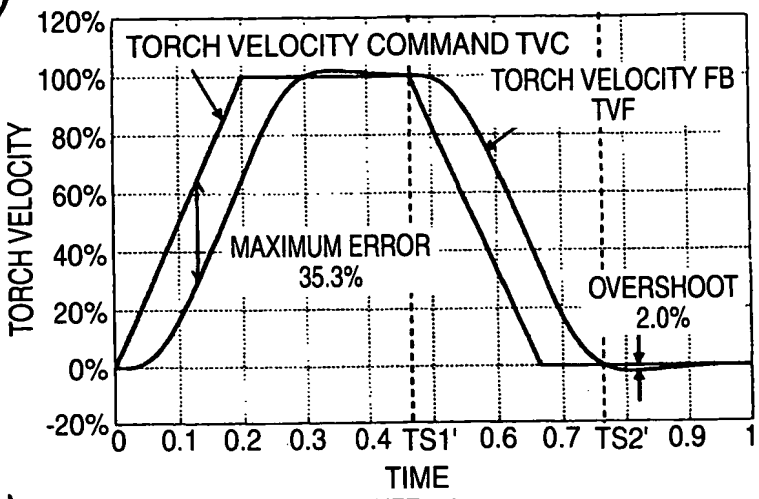



FIG. 11 (b)

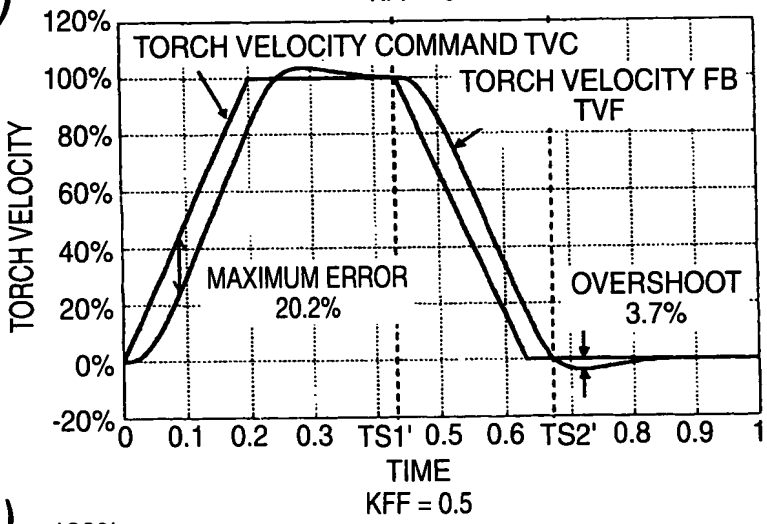



FIG. 11 (c)

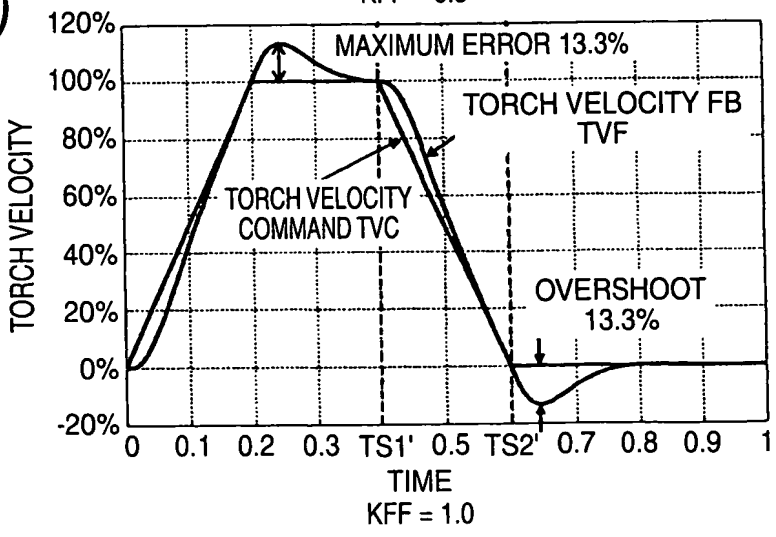


FIG. 12 (a)

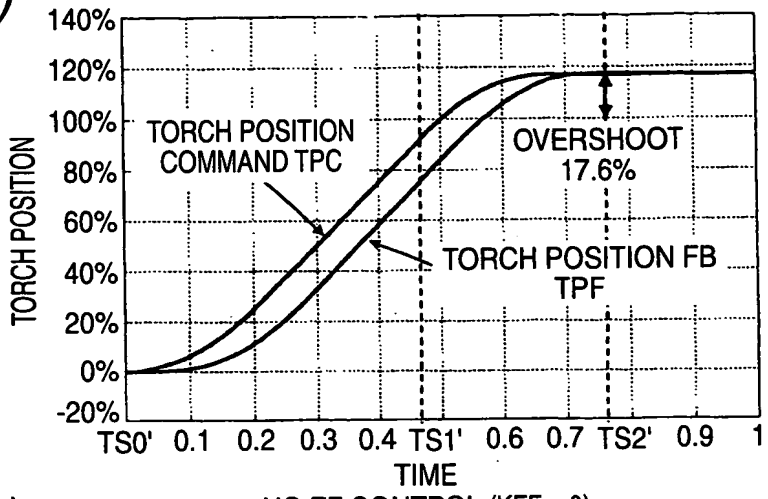



FIG. 12 (b)

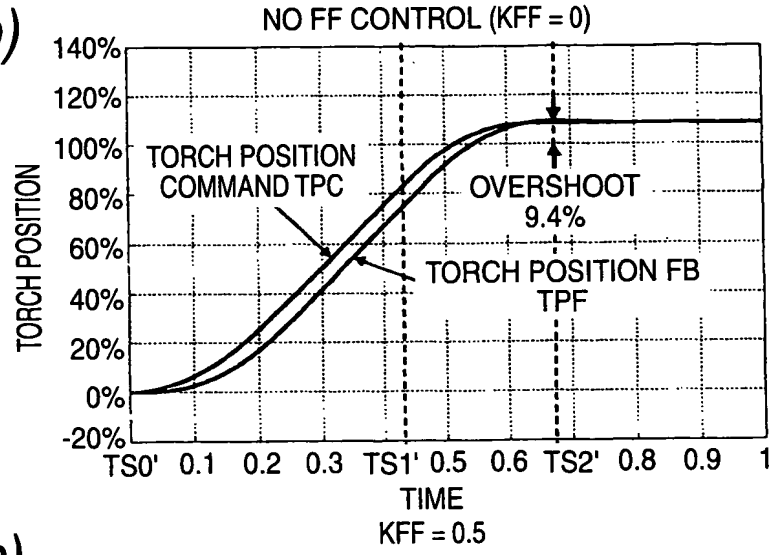



FIG. 12 (c)

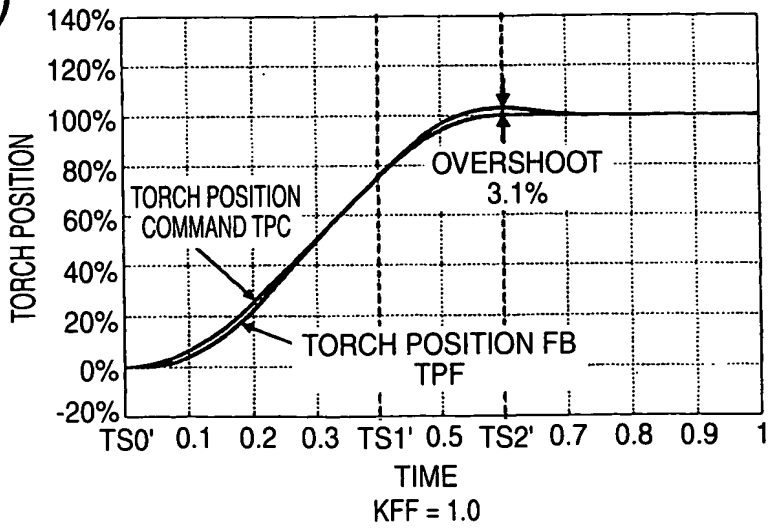


FIG. 13

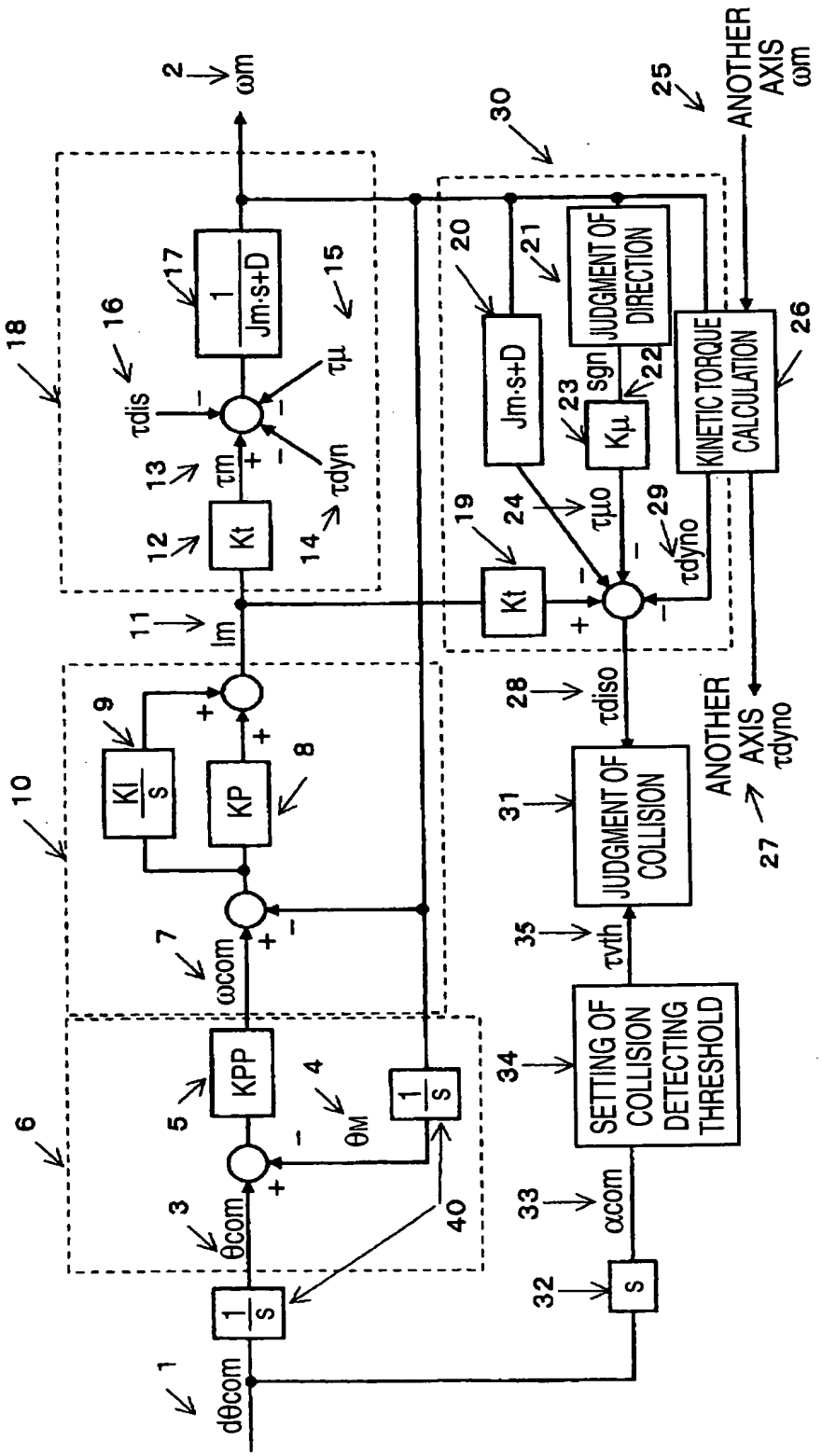

ωm
ANOTHER AXIS ωm
JUDGMENT OF DIRECTION
KINETIC TORQUE CALCULATION
Jm·s+D
sgn
Kμ
Kt
τμo
τdyno
τdiso
JUDGMENT OF COLLISION
ANOTHER AXIS τdyno
SETTING OF COLLISION DETECTING THRESHOLD
τvth
αcom
s
KI/s
KP
ωcom
KPP
θM
1/s
θcom
dθcom
τdis
τm
τμ
τdyn
Im

FIG. 14

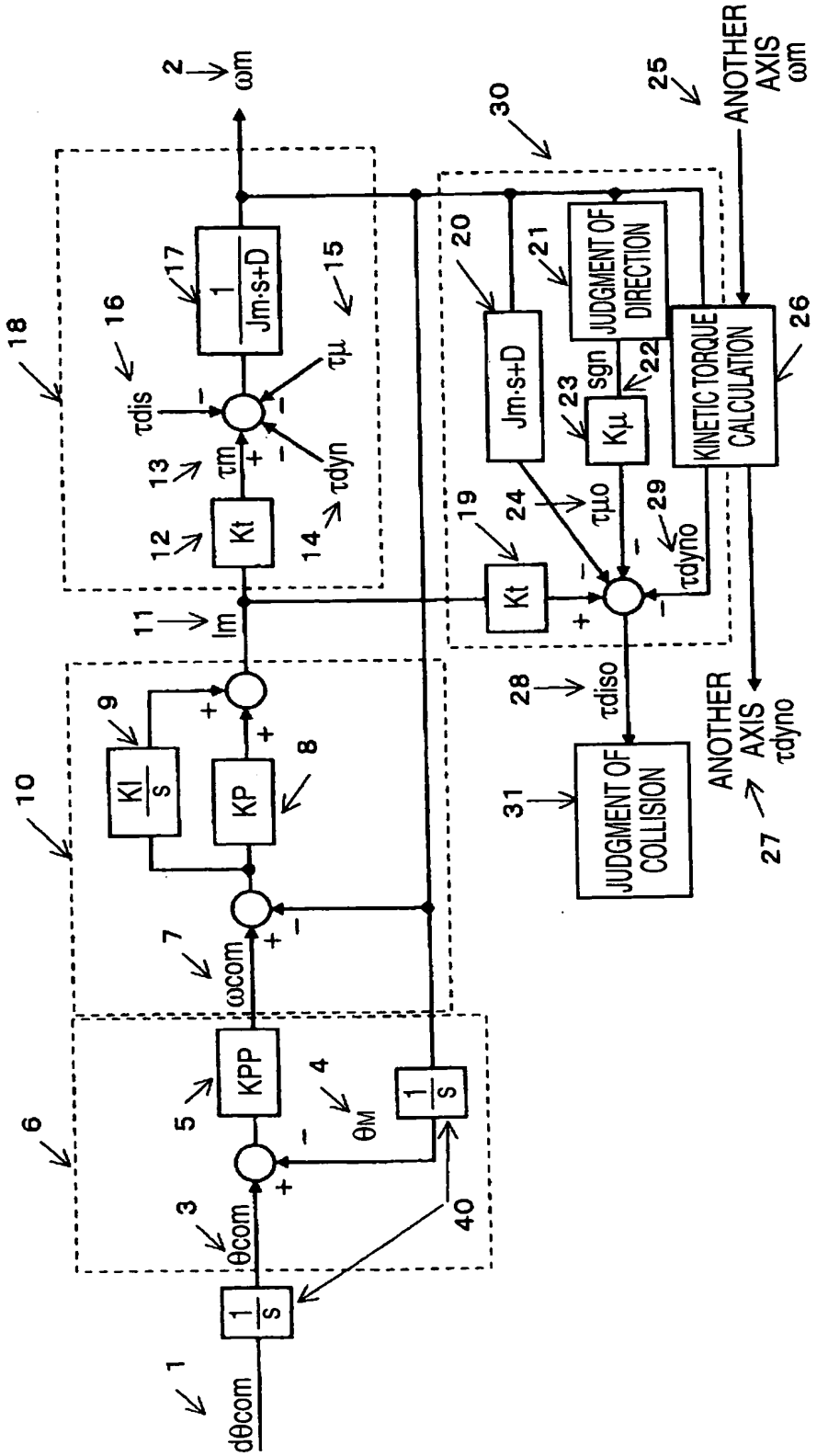

dθcom
θcom
ωcom
θM
ωm
τm
τdis
τμ
τdyn
Im
Kt
KP
KI/s
KPP
1/s
Jm·s+D
Kμ
sgn
JUDGMENT OF DIRECTION
KINETIC TORQUE CALCULATION
ANOTHER AXIS ωm
τμo
τdyno
τdiso
JUDGMENT OF COLLISION
ANOTHER AXIS τdyno

FIG. 15

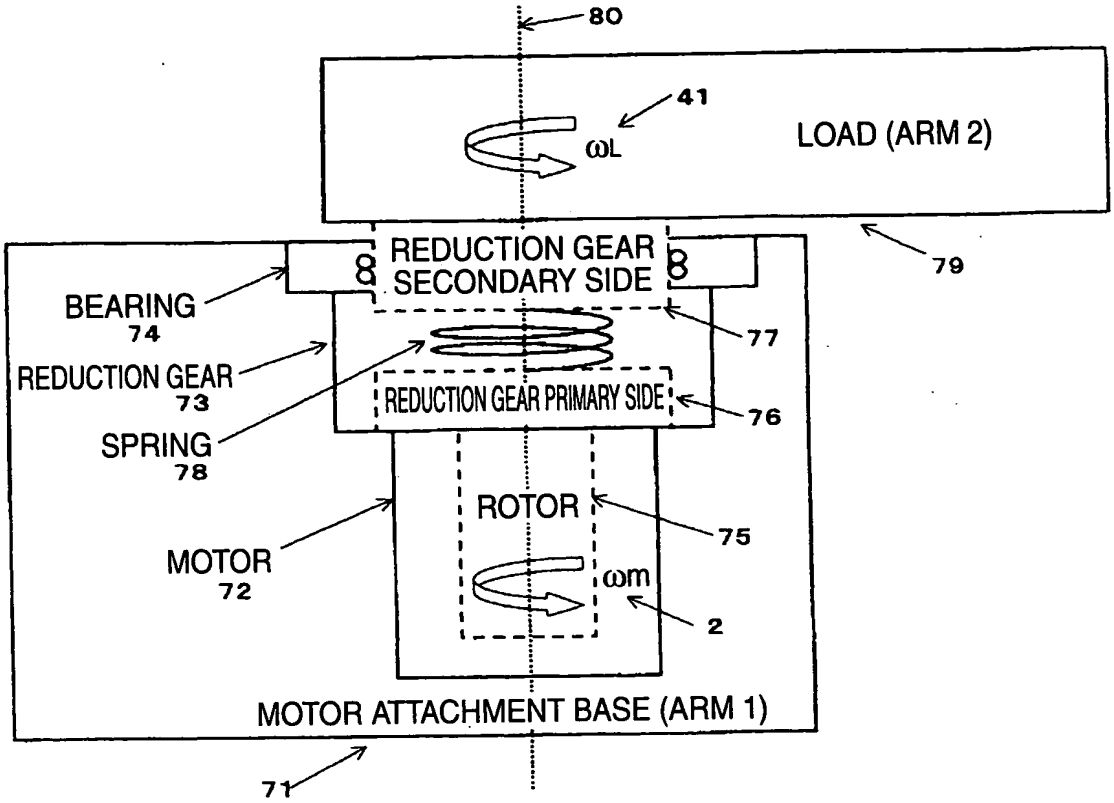

80
41
ωL
LOAD (ARM 2)
79
REDUCTION GEAR SECONDARY SIDE
BEARING
74
77
REDUCTION GEAR
73
REDUCTION GEAR PRIMARY SIDE
76
SPRING
78
ROTOR
75
MOTOR
72
ωm
2
MOTOR ATTACHMENT BASE (ARM 1)
71

FIG. 16

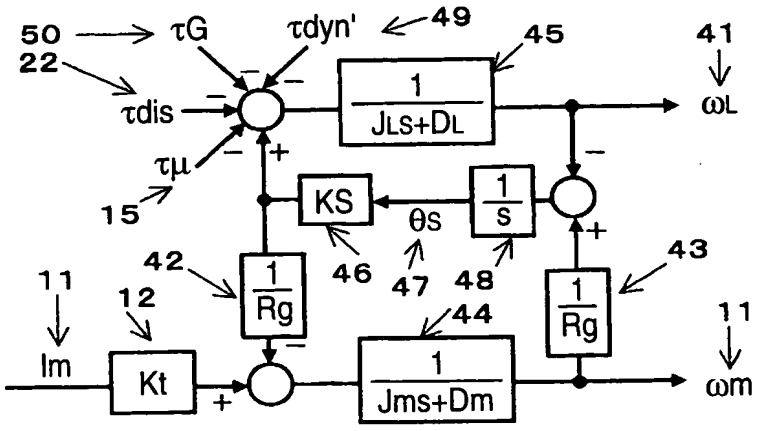

50
τG
τdyn'
49
45
41
22
τdis
1/(JLs+DL)
ωL
τμ
15
KS
θs
1/s
46
47
48
42
43
11
12
1/Rg
44
Im
Kt
1/(Jms+Dm)
ωm

FIG. 17

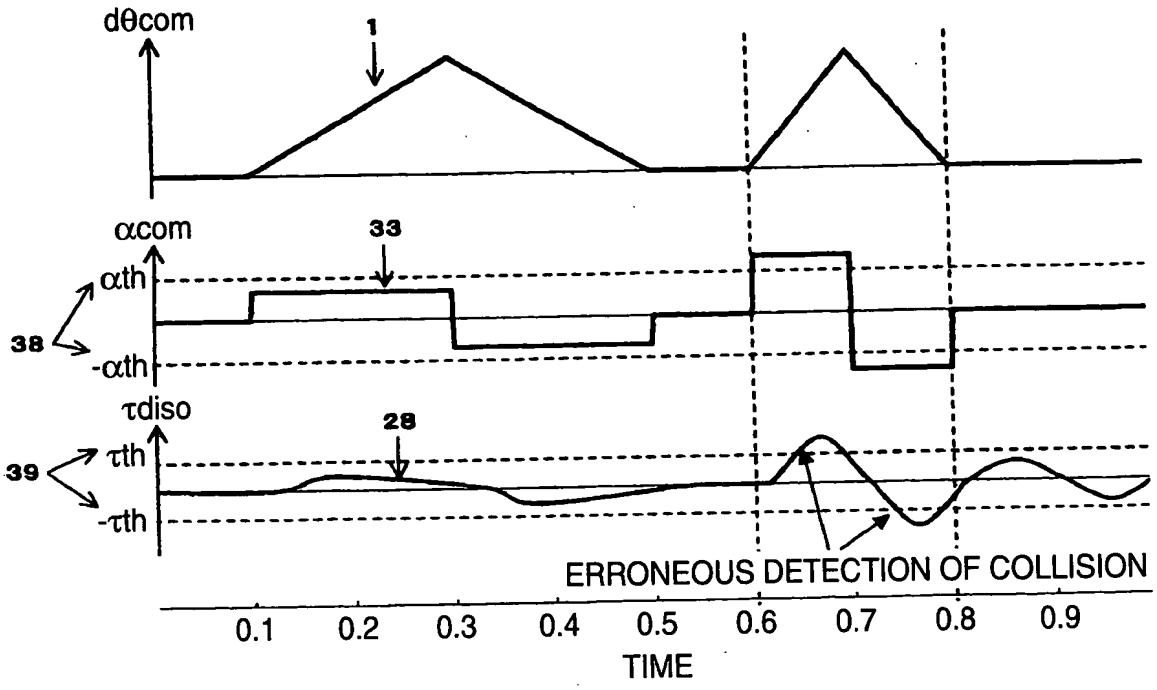

dθcom
1
αcom
33
αth
38
-αth
τdiso
28
39
τth
-τth
ERRONEOUS DETECTION OF COLLISION
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
TIME

FIG. 18

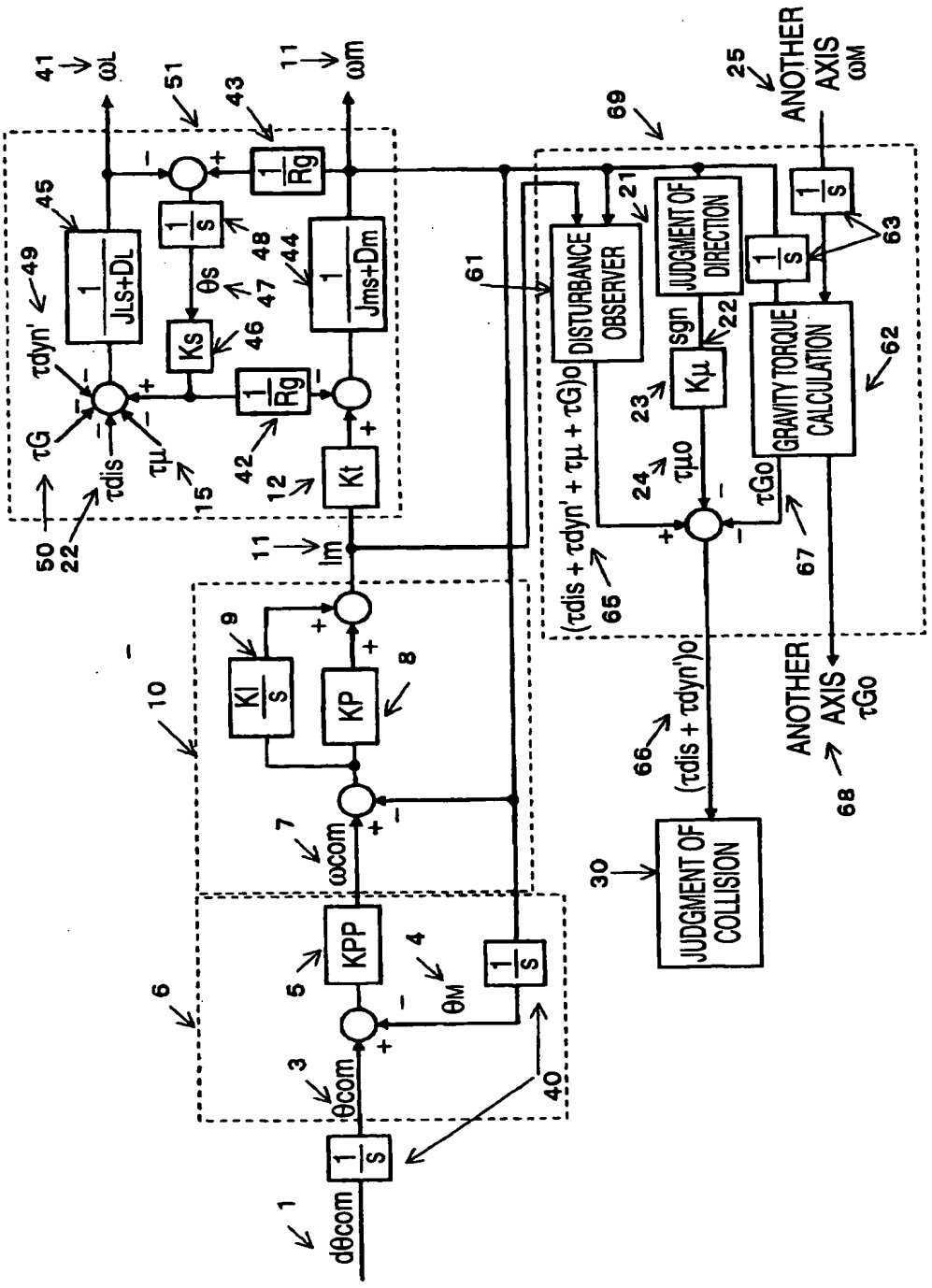

41
ωL
51
43
11
ωm
69
25
ANOTHER AXIS ωM
45
49
τdyn'
1/(JLs+DL)
1/s
48
θs
47
Ks
46
1/Rg
44
1/(Jms+Dm)
61
DISTURBANCE OBSERVER
21
JUDGMENT OF DIRECTION
1/s
63
sgn
22
Kμ
23
GRAVITY TORQUE CALCULATION
62
τG
τdis
τμ
15
42
12
Kt
τμo
24
τGo
50
22
11
Im
(τdis + τdyn' + τμ + τG)o
65
67
9
KI/s
8
KP
10
ANOTHER AXIS τGo
66
(τdis + τdyn')o
68
7
ωcom
30
JUDGMENT OF COLLISION
KPP
5
4
θM
1/s
6
3
θcom
40
1/s
1
dθcom

FIG. 19

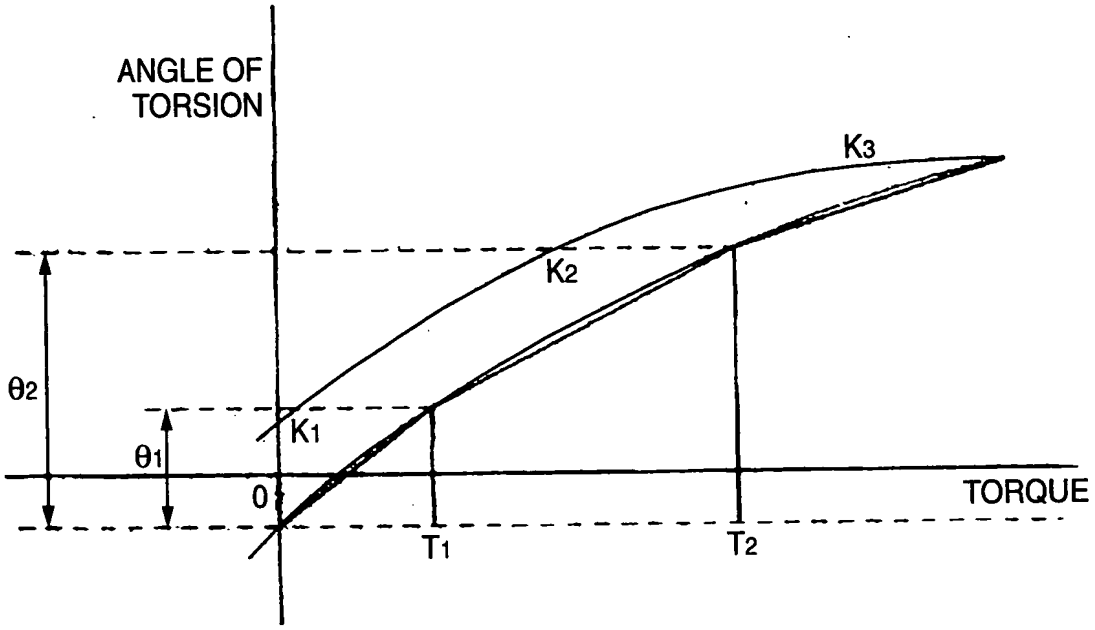

ANGLE OF TORSION
K3
K2
θ2
K1
θ1
0
TORQUE
T1
T2

FIG. 20

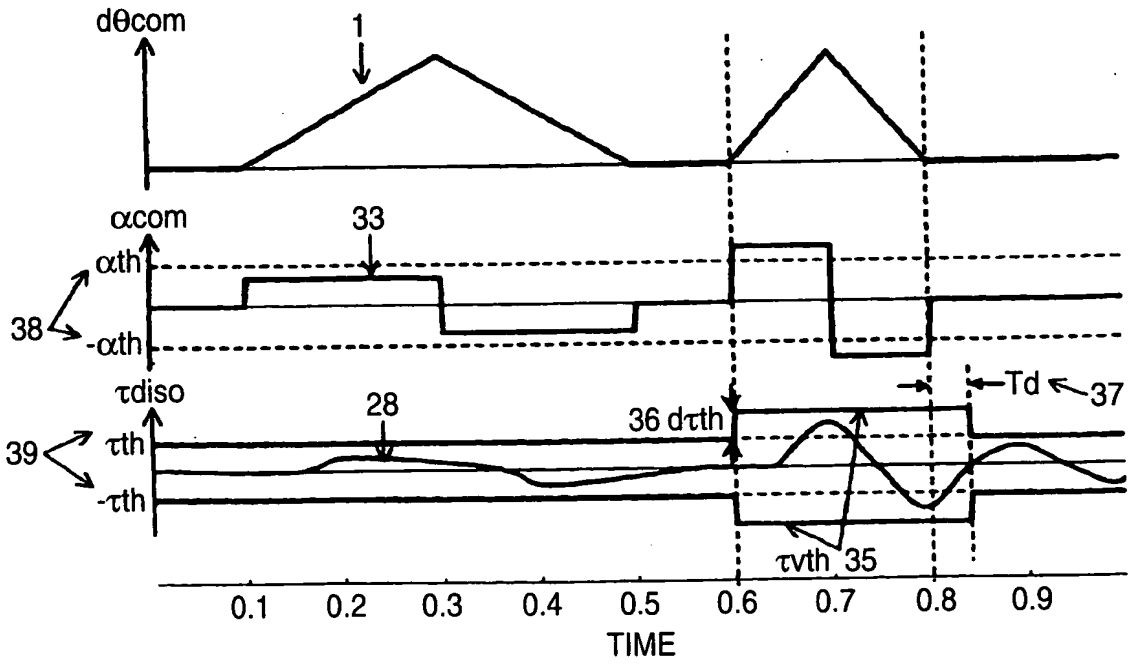
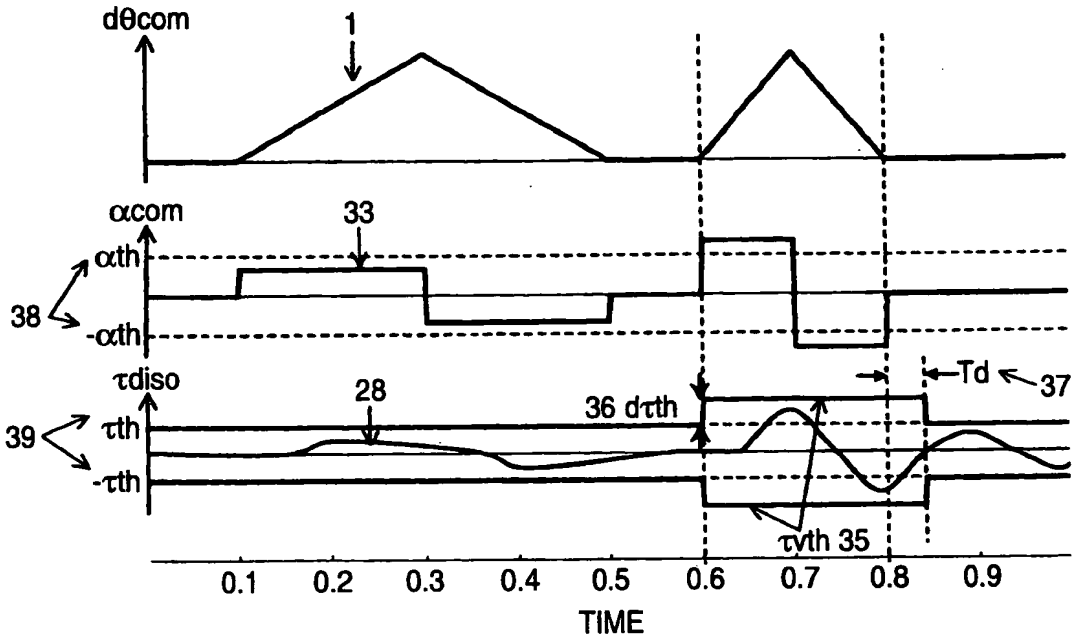

dθcom
1
αcom
33
αth
38
-αth
τdiso
28
36 dτth
Td
37
39
τth
-τth
τvth
35
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
TIME

FIG. 21


dθcom
1
αcom
33
αth
38
-αth
τdiso
28
36 dτth
Td
37
39
τth
-τth
τvth 35
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
TIME